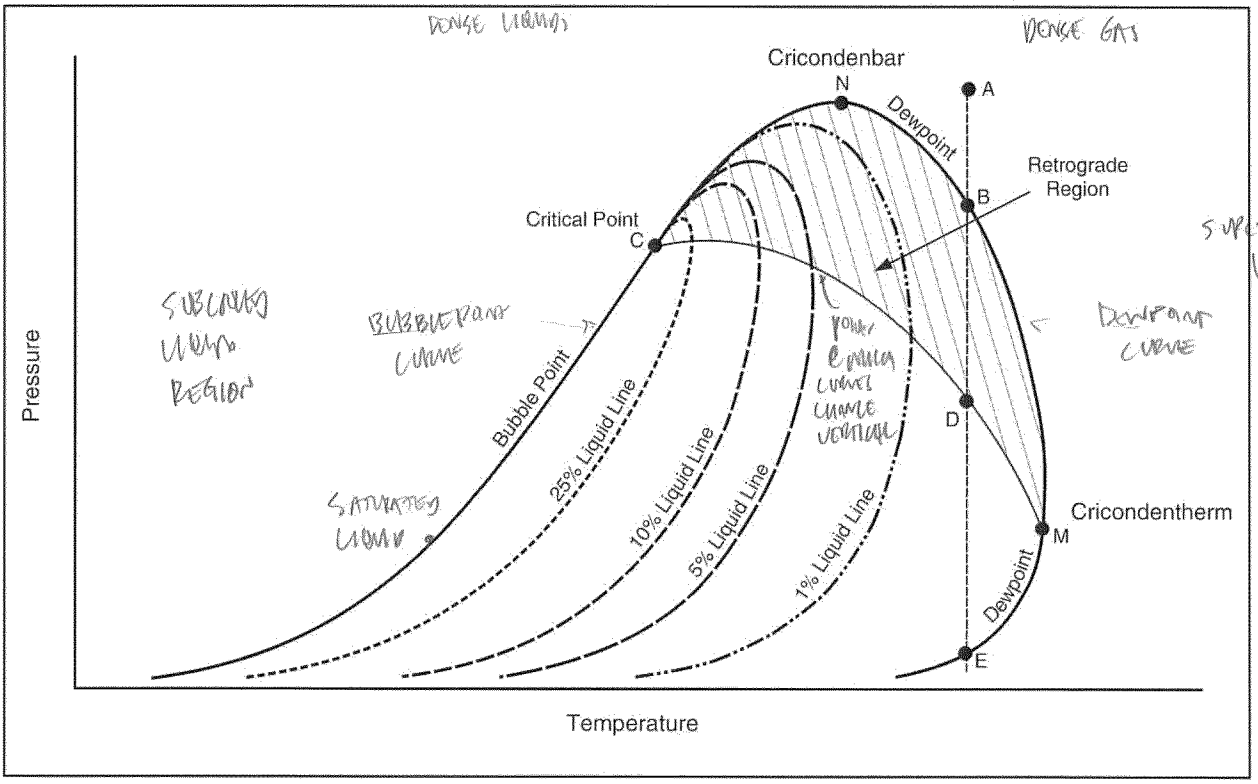
MULTICOMPONENT PHASE BEHAVIOR

For a multi component mixture such as natural gas which typically contains ten or more components, the depiction of phase behavior obviously becomes very complex! For expediency, we revert to a simple P, T representation (as we did with a pure component). However, we should understand that this representation is valid for a specific composition. As we work our way through processing steps in future sections, every change in composition will result in a new phase diagram. Nonetheless, the following is a typical natural gas phase diagram, and we can identify attributes that are common to most natural gas compositions.



Common attributes for any natural gas phase diagram are as follows:

The Envelope. The phase envelope itself is formed by the bubble point curve on the left and the dew point curve on the right. To the left of the bubble point curve is the all liquid region. To the right of the dew point curve is the all vapor region. (There is a third special region outside the envelope that is noted below). Inside the envelope is the two phase region. At each unique point in the two phase region, a liquid phase and a vapor phase exist and are said to be "in equilibrium" with each other. Each phase has a different composition than the overall natural gas composition depicted by the phase envelope, but *taken together* the two phases combine to equal the original natural gas stream in amount and composition.

The Critical Point. The critical point of a natural gas stream is a combination of several complex ideas, but for our purposes the critical point can simply be defined as the point where the bubble point curve and the dew point curve meet.

Cricondenbar. The pressure above which two distinct liquid and vapor phases cannot exist.

Cricondentherm. The temperature above which two distinct liquid and vapor phases cannot exist.

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Liquid "Quality" Lines. These are lines of constant liquid percentage inside the two phase region. Note that the lines are roughly parallel to the dew point curve, including lower percentage lines "bending over" at the top of the envelope to converge at the critical point.

Retrograde Region. The unique shape of the quality lines gives rise to a special region inside the phase envelope near the top called the retrograde region. Inside that region, gas behaves somewhat counter intuitively. For example, if the gas at point A is reduced in pressure, liquid begins to form at Point B even if the temperature does not change. As the gas is further reduced in pressure, more liquid forms. Further pressure reduction below Point D results in the "normal" phenomenon of liquid reduction as pressure declines. Similar anomalous behavior occurs when cooling gas at constant pressure in the retrograde region at high pressure. Liquid formation occurs as expected until the back side of the quality line is reached as it bends over toward the critical. At that point, further cooling causes the liquid to disappear! That is why the left side of the envelope above the critical point is also called part of the dew point curve.

Dense Phase Region. In a manner similar to the dense phase region for a pure component, the region above the *cricondenbar* (rather than the critical point) exhibits "dense phase behavior" (no distinct phase change, but rather a gradual change from a condition where the gas changes as it is cooled from a "dense gas" to a "light liquid").

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